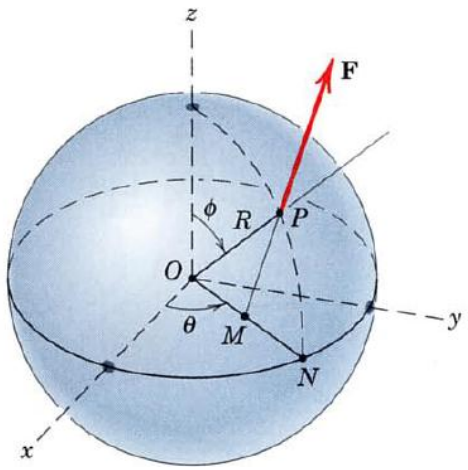
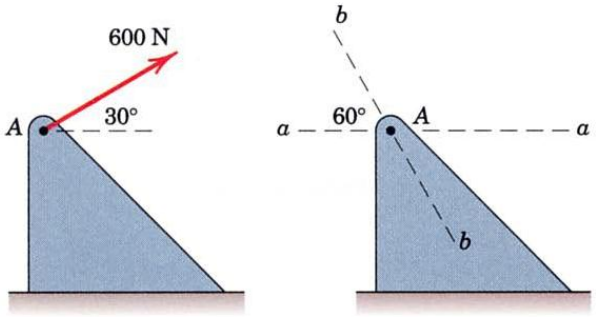
MECHANICS (ME10001)

Tutorial 1: Force System

1. A force F is applied to the surface of a sphere as shown. The angles θ and ϕ locate point P, and point M is the midpoint of ON. Express F in vector form using the x-y-z coordinates.

$$F\left[\frac{(2\sin\phi - 1)(\mathbf{i}\cos\theta + \mathbf{j}\sin\theta) + \mathbf{k}(2\cos\phi)}{\sqrt{5 - 4\sin\phi}}\right]$$



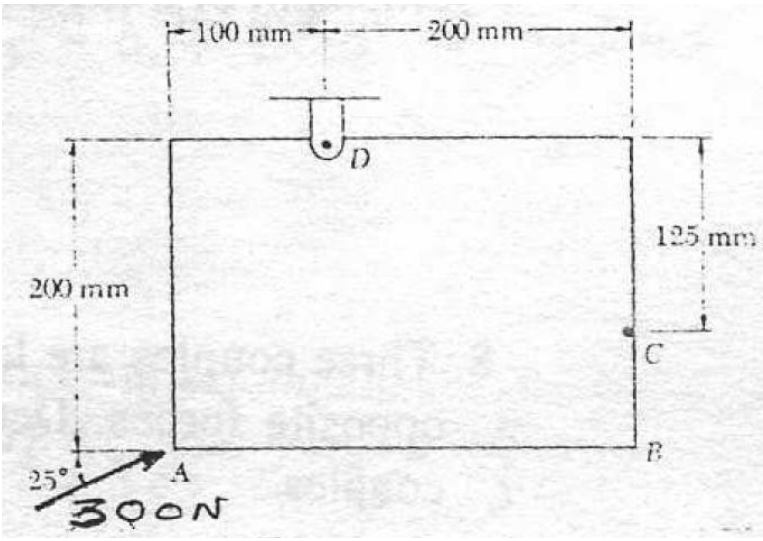


2. A 600 N force applied to the bracket at A is to be replaced by two forces, F_a in the a-a direction and F_b in the b-b direction. Which together produce the same effect on the bracket as that of the 600 N force. Determine F_a and F_b.

Ans: F_a=692.82 N, F_b=346.42 N

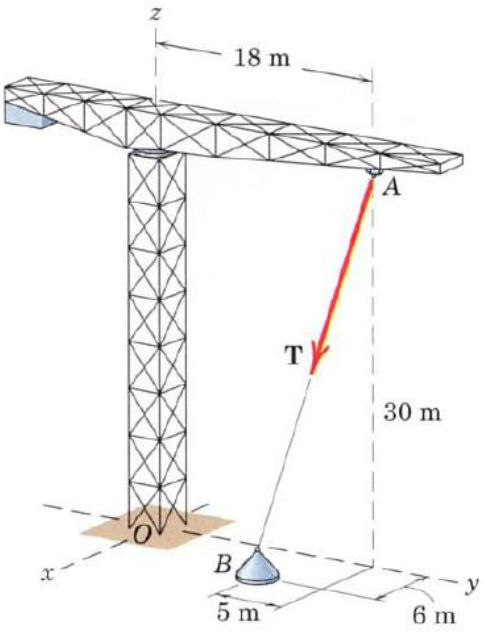
3. A 300 N force is applied at A as shown. Determine
   (a) the moment of the 300 N force about D,
   (b) the smallest force applied at B which creates the same moment about D.

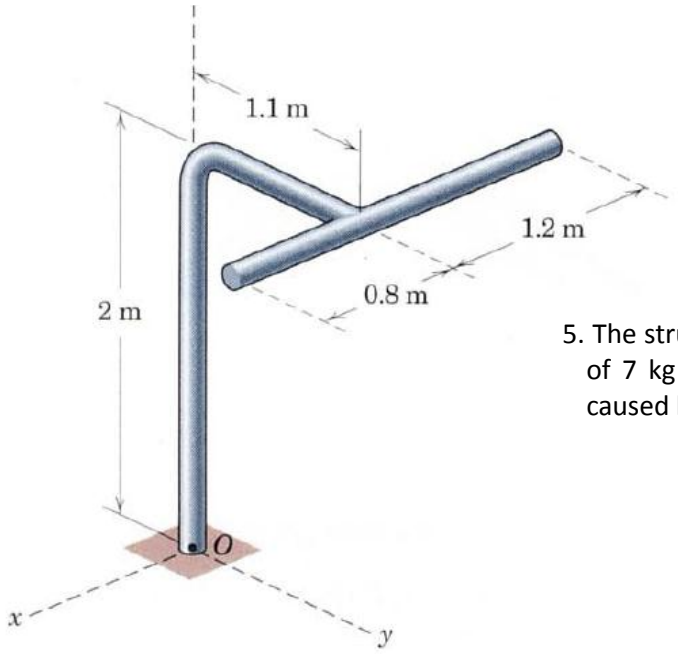
Ans: (a) 41.7 N m (b)147.4 N, 45^0



4. In picking up a load from position B, a cable tension T of magnitude 24 kN is developed. Calculate the moment which T produces about the base O of the construction crane.

Ans: (-301.94 i +139.35 j – 83.61 k) kN m



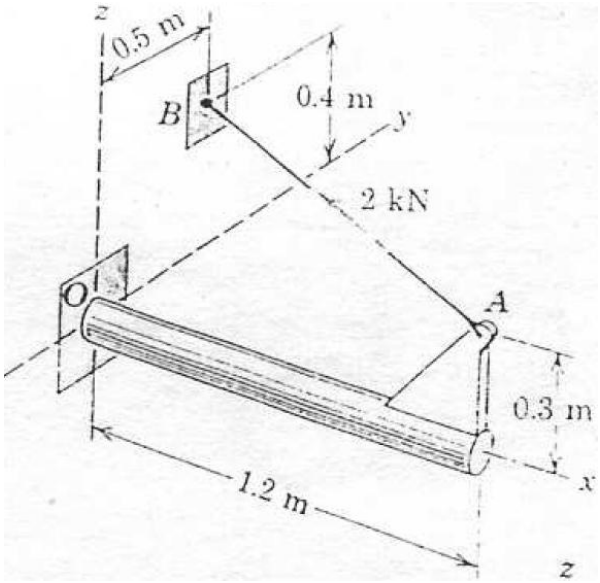


5. The structure shown is constructed of circular rod which has a mass of 7 kg per meter of length. Determine the moment Mo about O caused by the weight of the structure. Find the magnitude of Mo.

$$Ans.\ \mathbf{M}_O = -192.6\mathbf{i} - 27.5\mathbf{j}\ \text{N}\cdot\text{m}$$
$$M_O = 194.6\ \text{N}\cdot\text{m}$$

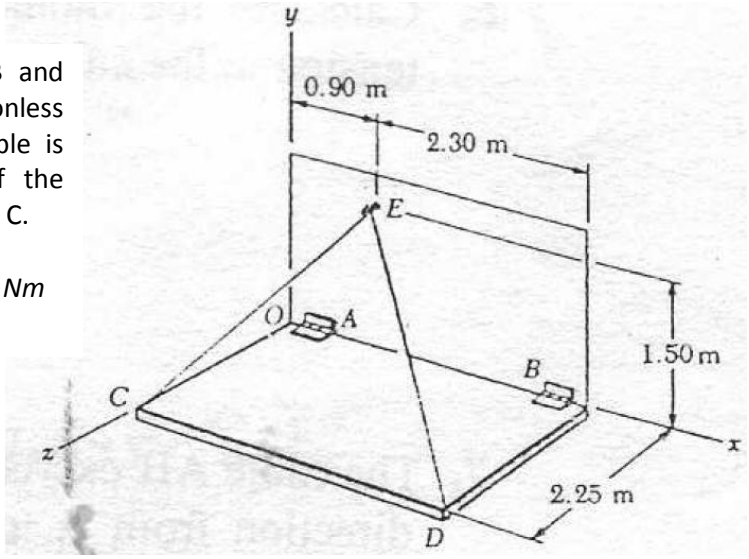
6. Calculate the moment about the z- axis of the 2 kN tension in the cable AB.

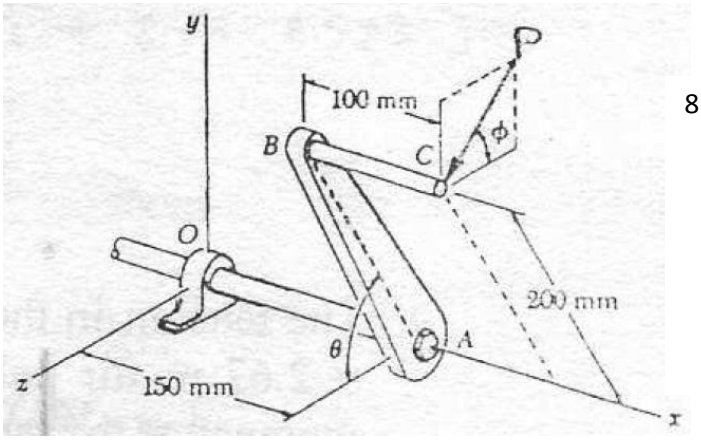
Ans: 0.92 kNm



7. The rectangular platform is hinged at A and B and supported by a cable which passes over a frictionless hook at E. Knowing that the tension in the cable is 1349N, determine the moment about each of the coordinate axes of the force exerted by the cable at C.

Ans: −1598 i + 959j Nm



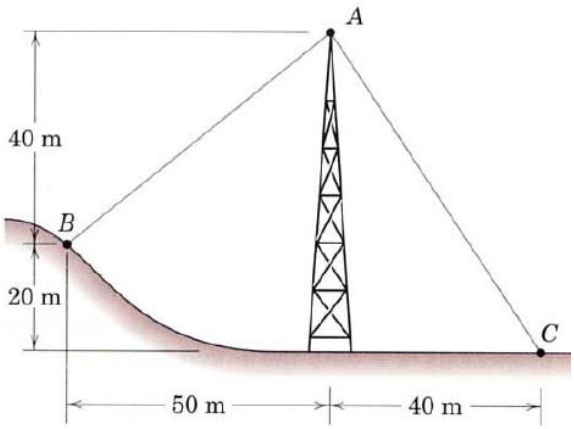


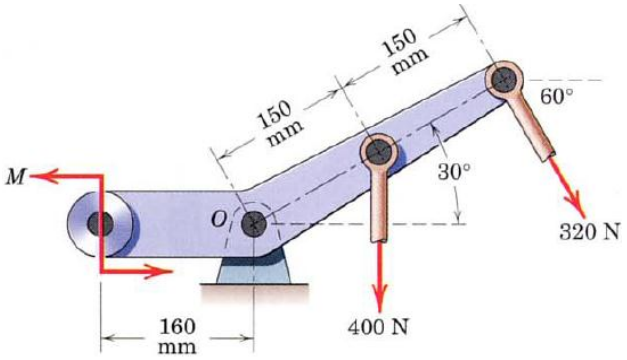
8. A single force P acts at C in a direction perpendicular to the handle BC of the crank shown. Knowing that Mx = +20 Nm, My = − 8.75 Nm, and Mz = − 30 Nm, determine the magnitude of P and the values of phi and θ.

Ans: P= 125N, $\phi = 74^0$ and $\theta = 53^0$

9. The guy cables AB and AC are attached to the top of the transmission tower. The tension in cable AC is 8 kN. Determine the required tension T in cable AB such that the net effect of the two cable tensions is a downward force at point A. Determine the magnitude R of this downward force.

Ans. $T = 5.68$ kN, $R = 10.21$ kN



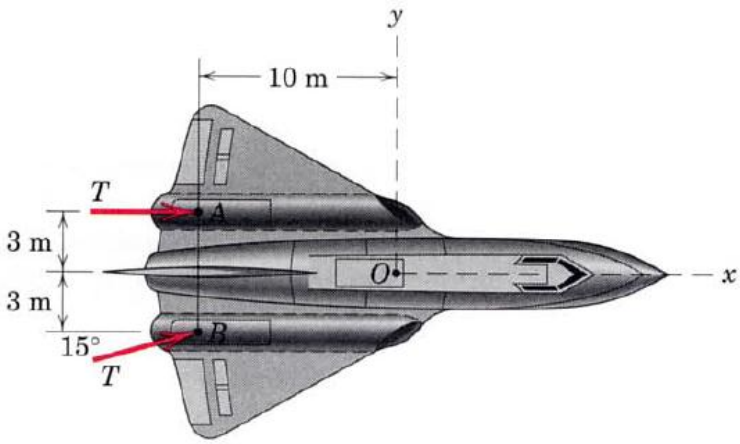


10. If the resultant of the two forces and couple moment M passes through point O, determine M.

Ans. $M = 148.0\ \text{N}\cdot\text{m}$ CCW

11. For the thrust configuration for an aircraft shown, determine the equivalent force-couple system at point O. Then replace this force-couple system by a single force and specify the point on the x-axis through which the force passes.

Ans: F_O=T(1.9659 i + 0.2588 j),
Mo=-2.6904T k, x=-10.3957 i



12. If engine 3 of the aircraft shown suddenly fails, determine the resultant of the three remaining engine thrust vectors, each of which has a magnitude of 90 kN. Also specify the y-z coordinates of the point through which the resultant passes.

Ans: F=270i kN, y=-4 m, z=2.33 m